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CRANBERRY INSECT PROBLEMS AND SUGGESTIONS FOR SOLVING THEM

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AN ABUNDANT water supply, permitting flooding and reflooding at the proper times, is the best remedy for insect injury in cranberry bogs, and when the sites of new bogs are to be chosen this should always be borne in mind. On cranberry land where the water supply is insufficient, however, spraying, sanding, and other measures will have to be used.

The cranberry has many insect enemies, but some of them are of importance only on dry bogs. The foliage is attacked by three species of "fireworms," the tipworm, spanworms, army worms, and the cranberry fleabeetle; the fruit is eaten by the fruitworm, blossom worm, cranberry katydid, and grasshoppers; the vine is attacked by the girdler, toadbug, vinehopper, spittle insect, mealybug, and Putnam and oyster-shell scales; and the roots are destroyed by the rootworm and white grubs. This bulletin gives brief descriptions of these pests, their life histories, and the means found most effective, in each case, in preventing their ravages and destroying them.

CRANBERRY INSECT PROBLEMS AND SUGGESTIONS FOR SOLVING THEM.[1]

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COMMERCIAL CRANBERRY CULTURE is an intensely specialized industry, limited to a few sections of this country, notably areas in Massachusetts, New Jersey, Wisconsin, Long Island, and a district along the coast near the mouth of the Columbia River in the Pacific Northwest. Troublesome insects occur in all these regions, most of which are also of economic importance on other plants.

Cranberry bogs usually are flooded in the wintertime, from December or January until April or May, and reflowed one or more times in the spring to eradicate insects. Occasionally a bog is flooded in the fall, immediately after picking, for a period of one or two weeks, a practice which aids materially in controlling the pests.

Insect problems may be disposed of with little difficulty where the bogs are constructed properly and ample provision is made for flooding and reflooding. Many bogs, however, have been laid out without supplying adequate flooding facilities, and hence the control of insects has become a very serious problem for some growers. New insecticides are coming to the front, and these may be of value in helping to control cranberry insects, but too much stress can not be laid upon careful provision for a water supply when plans are being made for the development of cranberry land.

[1] This bulletin supersedes Farmers' Bulletin 178, Insects Injurious in Cranberry Culture.

FOLIAGE-ATTACKING INSECTS.

BLACKHEAD FIREWORM.[1]

Three distinct species of the so-called fireworms—the blackhead, the yellowhead, and the red striped—are known to infest cranberry vines. Of these the blackhead fireworm is by far the most injurious. It causes very large losses annually in New Jersey and is well known for its destructiveness in Massachusetts, Wisconsin, Long Island, and the Pacific Northwest.

CHARACTER OF INJURY.

Injury produced by the three species of fireworms is very similar, but inspection of the webbed foliage soon will reveal the worms, disclosing whether the blackhead or one of the other kinds is at work, the distinction being indicated by the terms used as their common names.

Blackhead fireworms feed on various parts of the plant at different periods in their development, the total damage in cases of severe infestation finally giving to the vines a burnt appearance, which justifies the term "fireworms." The young worm, or larva, of the first brood usually burrows into the lower side of one of the lower leaves and for several days acts as a leaf miner (see fig. 1), after which it crawls to the tip of the upright and either bores into the unopened bud or makes a web, joining one or more of the terminal leaves to the bud, beneath which it feeds. As soon as new shoots of the vines are forced out the worm attacks the young leaves, webbing the topmost together (fig. 2), so that in its feeding it

FIG. 1.—Blackhead fireworm: Frass or castings over mines of newly hatched larvæ in cranberry leaves.

[1] *Rhopobota vacciniana* Pack.

is protected fairly well from its natural enemies. At this period a very good idea may be had of the acreage infested and the abundance of the worms.

Destruction of the terminal buds by the first brood causes a shortage of the crop and on many bogs the shortage amounts to practically the total crop of the area badly infested. First-brood feeding causes some browning of the foliage and a temporary checking of growth, but before the second brood appears the vines will put forth a considerable amount of fresh, green foliage.

FIG. 2.—Blackhead fireworm: Cranberry tips webbed by first brood of larvæ.

Second-brood worms appear in July and attack the new foliage as well as many of the leaves of the previous season, webbing them up so as to include in some cases several uprights. (Fig. 3.) In addition these worms eat blossoms and bore into many of the newly developed berries. The work of this brood gives to the bog a burnt appearance.

In late summer the vines again start to grow, some of the uprights producing buds that will fruit the following season, but the crop from these is likely to be a short one. Many of the chewed and skeletonized leaves drop from the vines, leaving the uprights bare except for some late growth at the tip.

DESCRIPTION AND SEASONAL HISTORY.

THE EGG.

This insect passes the winter in the egg stage. In July and August the moths place the eggs on the underside, rarely on the upper side of the cranberry leaves. For the most part the eggs are deposited fairly close to the ground, frequently on leaves springing from delicate and spindling uprights deep within the vines. The egg is flattened, disklike, yellow, and about one thirty-second of an inch in greatest diameter.

Hatching may take place in the following spring as early as April 20 on dry bogs, on vines exposed above the winter flowage, or on vines submerged in shallow water. If the winter flowage is removed May 10, eggs will be found hatching from that date until the latter

part of May. Deep flowage and heavy vine growth tend to delay the time of hatching. After the worm has emerged the eggshell

FIG. 3.—Blackhead fireworm: Webbing of cranberry shoots by second brood of larvæ.

appears shining whitish. The eggs of the second brood, appearing on the vines in late June and early July, require 5 or more days for hatching.

THE LARVA.

The larva is a dark green worm with shining black head and neck and measures about one-half inch in length. From the time of hatching, as indicated above, until growth is completed, about 18 or more days are required in the case of the first brood; the time required for the second-brood worms averages between 14 and 15 days. If the winter flowage is removed May 10, full-grown worms may be found the latter part of the month, although the majority will not reach full size until early June.

THE PUPA.

When the time for changing into the chrysalis arrives the habit of the worm varies somewhat in the cranberry districts. In the Eastern States the pupa will be found on the ground among fallen leaves or trash, usually naked, but sometimes in a lightly constructed web of silk woven on the surface of a fallen leaf. In Wisconsin the pupa is more often found in the webbed tips of uprights. The pupa is of various shades of brown, becoming nearly black just before the emergence of the moth. The pupa period of the first brood averages about 13 days, and in the second brood it is shortened to an average of 10 days.

THE MOTH.

The adult (fig. 4) is very small, measuring not more than one-half inch across the expanded wings, and is grayish brown. The forewings are marked with alternate light and dark bands of gray-brown shade. The moths fly little in the early part of the day, but at dusk they may be seen in their jerky flight going short distances a foot or two above the vines. Egg laying may occur within 24 hours after the emergence of the female.

FIG. 4.—Blackhead fireworm: Moth, or adult. Much enlarged.

SEASONAL ABUNDANCE OF LARVÆ.

Where the winter flowage is removed April 10, worms will be found in maximum numbers during the periods April 25–May 20 and June 18–July 10. Should the flowage be removed May 10, the periods of destructiveness will approximate May 15–June 10 and July 6–July 25.

TREATMENT.

REFLOWING.

When properly timed, reflowing is the most effective method of clearing a bog of

fireworms. The best results are obtained if the flowage is applied when the worms are about full grown, as at that time they succumb in fewer hours than when they are newly hatched. In the pupa stage not less than 4 days' reflowage is required to exterminate them. Just after hatching, when the worm is burrowing into a leaf, instances have been observed where 5 days of reflowing failed to kill.

One of the commonest and gravest mistakes in reflowing for this pest is the holding of the flowage for too short a period.

FIG. 5.—Improper reflowing of cranberry bog. Nearly every tip bears blackhead fireworms.

Holding of the winter flowage until May 10, followed by reflowage about May 28, keeping the vines completely covered for not less than 48 hours, has proved a very satisfactory method of ridding New Jersey bogs of fireworms. If the worms are very abundant, however, they will be likely to destroy all of the crop during the period May 10–May 28 by their feeding in the buds. This may be prevented in large measure by a preliminary reflowing for 48 hours, or by spraying, about May 17, with nicotine sulphate. (See formula under "Spraying," p. 9.)

If it is necessary to draw the winter flowage in early April, two reflows should be made where practicable, one about May 15, for 72 hours, and one about June 1, for 36 hours.

LATE HOLDING OF THE WINTER FLOWAGE.

Where the winter flowage was held until June 1 this method of treating worms on level, shallow-flowed bogs was found successful. It is essential, however, to keep the water just over the tips and to mow or burn any exposed tips. (Fig. 5.) The warmth of the shallow water causes hatching of the eggs under water and eventual drowning of the small worms.

On the other hand, a deeply flooded bog is known upon which considerable hatching of fireworm eggs occurred after the removal of the winter flowage, June 18.

SPRAYING.

After repeated failures in the control of the worms with arsenical sprays, such as arsenate of lead, arsenite of lime and Paris green, and with arsenicals applied as dusts, these materials have been discarded in favor of 40 per cent nicotine sulphate. This insecticide has a wide usage for insect pests and recently has been found of value against fireworms. It is not known definitely at this writing to what extent it will be effective where reflowing can not be practiced, but it has given very marked results in conjunction with reflowing.

For bogs without reflowage two applications are suggested after drawing the winter flowage May 10. Make one application about May 17 and a second application one week later.

Preparation of the nicotine-sulphate spray.—The proportions found effective in killing the blackhead fireworms are 1 part of 40 per cent nicotine sulphate to 800 parts of water. The material may be used much stronger without causing injury to vines or fruit, but the control of the worms will not be appreciably better. The addition of 2 pounds of fish-oil soap aids in spreading the insecticide. This spray should be applied as a moderately fine mist, about 200 gallons being used per acre, and it being borne in mind that it is mainly effective as a contact poison and not as a stomach poison.

For good results this spray must be applied when the small worms are in or near the tops of the uprights just before growth of new foliage is made. Once the worms become webbed up in leaves of the current season, the spray will not be so effective, because it will be impossible to wet many of them at that time.

YELLOWHEAD FIREWORM.[1]

The yellowhead fireworm is often troublesome in New Jersey but is of minor importance at present in other cranberry regions. As an apple pest it is known widely throughout this country. Its

[1] *Peronea minuta* Rob.

FIG. 6.—Yellowhead fireworm: Early-season work of the larvæ on cranberry.

control is an easy matter in most instances, and its presence in considerable numbers on a cranberry bog is usually an indication that the bog was planned without sufficient regard for proper flowage.

CHARACTER OF INJURY.

Injury resulting from the feeding of these fireworms is similar to that of the blackheads, causing the vines to appear as if fire swept. The foliage is webbed in much the same manner, permitting the worms to feed with some protection. The vines shown in figure 6 are typical of the work of the early broods, and those shown in figure 7 represent vine appearance in September, at which time much of the fruit is found wormy (fig. 8). Crates of berries may be noticed in storage houses late in September and during October that are infested with these worms, which sometimes are mistaken for the true cranberry fruitworm.

DESCRIPTION AND SEASONAL HISTORY.

This species is peculiar in that the appearance of the moth in summer is very different from that which it assumes in the fall and winter. The moths that develop in the fall are of a reddish gray color (fig. 9) and, notwithstanding the rigors of the climate, pass the winter hidden among vines or brush or sometimes in cranberry houses, although on warm, bright days they may be seen on the wing.

About April 1, egg laying begins, and the succeeding generations of moths are orange red in color (fig. 10). The moths are a little larger than the moths of the blackhead fireworm, and the same may be said of the worms. The lighter color of the worm and its shining yellow head serve readily to distinguish this pest from other fireworms. The eggs are yellow and under a lens will be found marked off into irregular hexagonal figures.

The pupa is dark brown to blackish, with a very prominent knob at the head extremity. It may be found in a silken cell among webbed uprights.

During the course of some experiments carried on in New Jersey in 1914, three generations of moths of the orange-red form were pro-

FIG. 7.—Yellowhead fireworm: Late injury to cranberry vines and fruit by larvæ.

duced prior to the last generation, which is of the gray color, thus showing that in New Jersey, at least, four generations may occur, although three should be considered normal.

The early broods of worms develop on dry bogs, or on the upland, or on flowed bogs where some of the vines are not covered by winter flowage. They are likely to go unnoticed, and steps to combat them are seldom taken until the berry feeding and extensive webbing of the later broods is begun. The last brood is slower of development and will be found infesting fruit to a considerable extent in September and October.

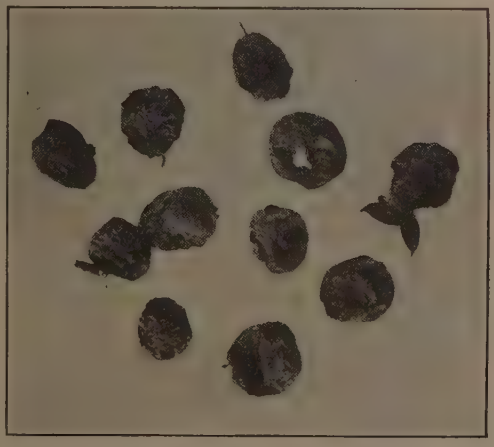

FIG. 8.—Yellowhead fireworm: Work of larvæ on cranberries.

TREATMENT.

LATE HOLDING OF THE WINTER FLOWAGE.

Bogs can be readily cleared of yellowheads

FIG. 9.—Yellowhead fireworm: Moth, or parent insect, gray form. Much enlarged.

by holding the winter flowage one season until May 10. If this is done, the wintering moths will be compelled to lay their eggs on the upland, and very rarely will the worms of the succeeding generations work their way back to the bogs.

Parts of bogs that can not be winter-flowed are undesirable holdings and are better if left unplanted. They serve as breeding places for a number of undesirable insects.

SPRAYING.

Arsenical poisons are reputed to be more effective against yellowheads than against blackheads. Arsenate of lead at the rate of from 3 to 5 pounds of the paste to 50 gallons of water is recommended for application as soon as newly hatched worms are discovered. In view of the surprising success obtained in the control of the latter worms with 40 per cent nicotine sulphate, however, the suggestion is offered that growers who have dry bogs infested with yellowheads spray them twice at intervals of a week just before new leaves begin to appear at the tips of the uprights, using 40 per cent nicotine sulphate (1 to 800) at the rate of 200 gallons per acre. (See directions for preparation of nicotine sulphate, p. 9.)

RED-STRIPED FIREWORM.[1]

At the time of the publication of Farmers' Bulletin 178, "Insects Injurious in Cranberry Culture," it was thought that the red-striped individuals noted among infestations of yellowhead fireworms were simply a variety of the latter species. This conclusion has been shown to be erroneous, and in both Massachusetts and New Jersey it has been found that the red-striped worms develop into moths of a distinct species.

This pest will be found almost invariably along with yellowhead infestations, the conditions for one being suitable for the development of the other. It is essen-

FIG. 10.—Yellowhead fireworm: Moth, or parent insect, orange-red form. Much enlarged.

[1] *Gelechia trialbamaculella* Cham.

tially a dry-bog species, occurring also on the upland as a rather extensive feeder on the huckleberry and blueberry.[1]

Description and Seasonal History.

Hibernation of the red-striped worms differs from that of the other fireworms in that the winter is passed in the worm stage. In late fall

Fig. 11.—Red-striped fireworm: Work of larvæ on cranberry.

the worm becomes dormant in a narrow, tubular case of frass-covered silk, formed in the uprights among badly mangled leaves (fig. 11), and remains therein until the following spring. Most of these bunches of brown, webbed leaves, with the encased worms, drop to the ground during the winter. Emergence of the moths begins in May and a second generation of moths appears in July and early August. The moth is dark brown with white face and three small

[1] Notably *Vaccinium corymbosum*.

FIG. 12.—Red-striped fireworm: Larva. Considerably enlarged.

white dots on each forewing. Under a hand lens other smaller white spots may be seen dotted over the wings.

Hibernating worms are parasitized heavily and can not withstand winter flowage. Narrow red stripes running longitudinally along the body (fig. 12) serve to distinguish them from the other fireworms. The worm always lives in a somewhat loosely constructed case among the foliage, and, when full grown, uses the case for a cocoon in which to pass the pupal stage.

The eggs are pearl white, very small, irregular in outline, but very plastic. They are placed under loose pieces of bark on the woody parts of the vines, beneath dormant buds, and in the axils of leaves. (Fig. 13.)

TREATMENT.

WINTER FLOWAGE.

Bogs that can be winter-flowed so that all portions are covered are not troubled by red-striped fireworms.

SPRAYING.

This pest will rarely be detected on the vines until mid-August, at which time an application of paste arsenate of lead (3 pounds to 50 gallons of water) should suffice to control it.

CRANBERRY TIPWORM.[1]

The cranberry tipworm appears to be one of the most common and most generally distributed of cranberry insects, although the extent of its injury is not appreciated fully. It has caused serious losses in Massachusetts and its injuriousness is coming to be recognized more fully in New Jersey. Reports of its work have been received recently from the Pacific coast cranberry district and it is a pest long established in Wisconsin. Until recently its life history was a matter of much conjecture, but lately some of the obscure points have been cleared up.

[1] *Dasyneura vaccinii* Smith.

Character of Injury.

The work of the first brood of tipworms, occurring in May and June, is of little consequence as compared with that of the later brood, occurring in July. In both instances the topmost leaves, usually two small ones facing each other, become cupped, their tips bending toward each other and their external surfaces appearing whitish. This result is effected by the feeding of the maggots on the interior surfaces of the leaves, where they rasp the issues with a peculiar horny process on the underside of the body, causing the cell contents to flow so that they may be absorbed through the mouths of the tipworms.

The topmost leaves die and sooner or later break off, leaving a black stub. (Fig. 14.) New growth springs up to replace the old, but about the time it attains an inch or two the attack is repeated by the next brood of tipworms.

When the first brood is at work the growing tip is killed above the point where the blossoms have started, so that the crop of the current season is not affected appreciably; but the July brood of worms destroys many tips upon which no new growth or buds are produced, consequently no fruit develops on these uprights the succeeding year. On the other hand, two or more buds are occasionally found springing from an injured upright, all of which develop fruit.

A considerable number of counts and observations show, however, that buds springing from the sides of injured tips produce little fruit in comparison with buds borne at the terminals of the uprights. In other words, side buds usually develop into leaf shoots, which is particularly true on weak-vined bogs or bogs lacking in plant food.

Runners and uprights, alike, are attacked, the injury to the former serving rather as a mild form of pruning.

Fig. 13. — Red-striped fireworm: Eggs on woody part of cranberry vines. Much enlarged.

Description and Seasonal History.

The manner in which this species passes the winter was long a subject of conjecture, but recent studies have shown that the worms of the

FIG. 14.—Cranberry tipworm: Tips of uprights killed by tipworms.

last brood descend to the ground to form their cocoons and remain there until the following spring. Thus hibernation occurs on the bog and is not affected appreciably by ordinary holding of the winter flowage. The hibernating cocoon is a very small, whitish, flattened oval case of closely spun silk and usually will be found attached to a fallen leaf or bit of trash, but also may be found fastened to a woody stem a few inches above the ground. The cocoons of the first brood of worms appearing in the spring occur in the damaged leaves at the tips of uprights or runners.

In the late spring the orange-red or yellowish grub (fig. 15) changes into a brown pupa and shortly before the time for the fly to emerge the pupa works its way out of the cocoon through a slit at one end. The adult is a very delicate, two-winged fly whose extended wings measure not more than an eight of an inch from tip to tip. (Fig. 16).

The eggs are colorless, very slender, slightly curved, almost microscopic, and have been seen to be deposited on leaf surfaces at the tips of the uprights.

Two generations are known in Massachusetts, and present information indicates that in New Jersey the insect is commonly of two generations, although a partial third perhaps may develop upon bogs from which the winter flowage is drawn early.

TREATMENT.

SANDING.

Extensive observations made on certain Massachusetts bogs, by Dr. H. J. Franklin, have shown that infestations may be reduced to a minimum by sanding the bog lightly every other year. Bog con-

ditions in New Jersey are so different, however, that a much heavier coat of sand would be required on many of the bogs, owing to the fact that they were prepared originally without sanding, and that resanding is not a common practice. If sanding is to prove a success as a control measure, it must be applied thoroughly, covering all of the litter beneath the vines at least one-half inch.

FIG. 15.—Cranberry tipworm: Injury to cranberry tip by larvæ. Much enlarged.

REFLOWAGE.

The usually efficacious method of clearing worms from a bog by reflowage does not meet with success in killing tipworms, because these tiny maggots can withstand submergence for a longer period than that during which it is safe to have the growing vines covered.

Well-nourished vines generally recover better from tipworm injury than weak and neglected vines; and from the results of recent experiments there is some reason to believe that an application of commercial fertilizer, particularly on savanna land, is helpful in enabling the vines to set buds after a tipworm attack.

FIG. 16.—Cranberry tipworm: Adult fly. Much enlarged.

SPANWORMS.

Looping, or measuring, worms, otherwise known as spanworms, are periodically abundant, but probably are more injurious on Massachusetts bogs than on those of any of the other cranberry sections. Recently in New Jersey they practically have not been known to cause serious injury.

FIG. 17.—Cranberry fleabeetle: Adult, or beetle. Much enlarged.

Four or five species are known to be of economic importance to the cranberry, and the fact that an outbreak may develop unexpectedly during any summer is a strong reason for frequent inspections of the bogs. When at rest among the vines and foliage the worms are difficult of detection and it is only when they start into motion that they are readily noted.

An ordinary insect-collecting net, the appearance of which in the hands of a man afield is often the subject for much merriment, should have a place, nevertheless, as part of the equipment of every cranberry bog. Sweeping the vines with a net is one of the surest ways of detecting an unsuspected insect infestation and this practice will aid in the discovery of invasions of spanworms.

The customary treatment for these insects is the application of a spray of arsenate of lead or Paris green.

ARMY WORM AND FALL ARMY WORM.

In seasons of army-worm[1] abundance it is not an unusual thing to find these worms infesting cranberry bogs. As a general rule they prefer grasses for food and will feed upon them if the bog is not a clean one, before doing much feeding on the vines. There are times, however, when the vine feeding becomes a serious matter and a remedy is sorely needed.

Another worm, very similar to the true army worm and known as the fall army worm,[2] is likely to cause severe losses on bogs from which the winter flowage is removed in July. The moths advancing northward from the Southern States appear to be attracted to bogs recently bared of the flowage and there they lay their eggs in preference to adjoining bogs from which the flowage was removed at the normal time.

Where practicable a prompt reflowage, preferably during cloudy weather, will suffice to kill or drive either of the above species to the shore, where they may be destroyed by the use of a knapsack sprayer delivering a spray of burning kerosene. If reflowage can not be practiced, either the poisoned-bran bait as recommended in this bul-

[1] *Cirphis unipuncta* Haw.

[2] *Laphygma frugiperda* S. & A.

letin for grasshoppers (p. 27) or spraying with some arsenical may be found serviceable in reducing the numbers of the insects.

CRANBERRY FLEABEETLE.[1]

On young plantings the small, black beetle with red head, known as the cranberry fleabeetle (fig. 17), is often disastrously injurious.

FIG. 18.—Cranberry flea-beetle: Injury to cranberry foliage and fruit.

During the summer following the setting out of new vines the beetles attack the leaves, more often the lower sides, eating off the tissue but leaving the veins, so that the leaves appear to have been skeletonized. (Fig. 18.) This feeding may be so severe as to render replanting

[1] *Systena frontalis* Fab.

necessary the next season. Older vines are attacked, but with less serious consequences.

The beetles first appear on the bogs and on brush along the dams during early July and remain throughout the summer. Indeed it is not unusual to find them feeding in the early part of October. Egg laying begins in late July, with deposition just below the surface of the ground. Hatching takes place the following May, but nothing is known of the habits of the little grubs on cranberry bogs except that they remain in the soil and are not thought to be extensive feeders on cranberry roots.

TREATMENT.

Experiments conducted in cages have shown that the beetles feed ravenously upon unsprayed vines, but leave almost untouched those sprayed with Bordeaux mixture and arsenate of lead. When spraying bog areas it is customary to omit spraying the young plantings, because they are not expected to bear fruit; but probably it would pay well to spray these sections with Bordeaux mixture and arsenate of lead (3 pounds of the paste or 1½ pounds of the powder to 50 gallons of Bordeaux mixture) when the usual rot sprays are applied. Leaves of young vines often are noted in badly diseased condition due to the attack of one of the rot diseases of the cranberry fruit and it is therefore doubly important to spray them where the foregoing insect and fungous troubles prevail.

FRUIT-ATTACKING INSECTS.

CRANBERRY FRUITWORM.[1]

Probably the most troublesome insect enemy of the cranberry in Massachusetts and Wisconsin, and one which causes heavy losses of fruit annually, is the cranberry fruitworm. In New Jersey the pest is of minor importance, although each season it may be found in scattering numbers throughout the cranberry region. The reason for its scarcity in New Jersey is not clear. Apparently conditions are favorable for its development in large numbers, but as a matter of fact the fruitworm is of so little importance in that State that the growers are not finding remedial measures necessary. There is only one brood, but, owing to the manner of feeding and hibernation of the larvæ, successful control is very difficult.

CHARACTER OF INJURY.

The first sign of its work, premature coloring of the berries, is well known to most growers. Upon hatching, the larva goes to some point near the stem end of the berry, burrows into the flesh, and closes

[1] *Mineola vaccinii* Riley.

the entrance hole with a thin, silken web. The seeds are eaten and usually some of the pulp in the first berry, after which the berry is vacated and the larva attacks another.

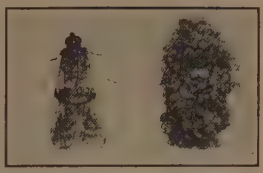

Fig. 19. — Cranberry fruitworm: At right, cocoon; at left, moth. About twice enlarged.

The berry turns red prematurely soon after it is attacked, and gradually shrivels, but may hang on the vine until another spring. The entrance to the first two or three berries is closed by a silken web, unless the worm can fasten adjacent berries together and thus pass from one to another without exposing itself to the attack of parasites. The number of berries destroyed varies with their size, but most of the pulp is eaten in all except the first.

Frequently larvæ that are late in maturing are carried in the berries into the warehouses, and in some cases the number has been so great that a large part of the crop has been ruined in storage.

Description and Seasonal History.

HIBERNATION.

Upon completing its feeding the larva descends to the sand under the vines on or near the surface of which it spins an oval cocoon about five-sixteenths of an inch long (fig. 19, at right). The cocoon usually is composed of grains of sand held together with strands of silk, but lacking sand the worm will not refuse peat or trash for this purpose. Each year a few larvæ spin up within the last berry which they attack. Although the cocoons are not impervious to water, the larvæ hibernate successfully under the customary winter flowage. Hibernation begins in August and continues until the following June or July.

THE LARVA.

The newly hatched larva usually enters the berry near the stem end, but most berries, after the first two, are entered at the side, and in only the first two or three is the entrance closed.

The larvæ are active from about July 1 to August 30, but also may be found in September within the berries. At this time the worm measures slightly more than half an inch in length and is green, tinged with red on the back. The head is yellowish, with brown mouth parts. A few sparse, long hairs clothe the body. (Fig. 20.)

THE PUPA.

In the pupa stage the insect is at first whitish but soon changes to yellow and a few days before emergence to dark brown. Pupation

commences within the cocoons in late May and June on winter-flowed bogs and slightly earlier on dry bogs.

THE ADULT.

Moths appear in numbers on the bogs in July and fly for a period of about a month. They hide among the vines during the day but become quite active in the evening. The forewings are dark ash gray, with a distinct pinkish tinge, and mottled with white and blackish. Two dark dots on a whitish patch near the front margin of each forewing will aid in recognizing this pest. The hind wings and the underside of both pairs are shining grayish brown. (Fig. 19, at left.)

THE EGG.

The egg is flattened, disklike to oval in outline, and so plastic when laid that it adapts itself readily to any irregularity of the surface on which it is deposited. In appearance, at first white, then watery

FIG. 20.—Cranberry fruitworm: Larva. Much enlarged.

translucent, they soon become pale yellow. The eggs usually are deposited in the calyx cup under the lobes, but they may be on any part of the berry. The period of incubation is about 5 days, but may be prolonged to 8 days in one which is parasitized.

TREATMENT.

Spraying with arsenicals has been tried repeatedly for the control of the fruitworm, but with so little success that it can not be recommended.

Growers very generally recognize that late holding of the winter flowage serves to keep fruitworms in check; the evidence in Massachusetts is that holding the flowage until May 20 will prove beneficial if practiced every other year. The early application of the winter flowage in the fall has not proved as valuable as the late holding in the spring. Recent studies of Dr. H. J. Franklin at the Massachusetts State Bog have shown that fall flooding after picking is of considerable value in destroying fruit worms.

In the case of a bog that has become unprofitable or is barely paying its way, owing to its infestation by fruitworms and other insects,

it probably would be found most satisfactory to hold the winter flowage until July 1, or even mid-July, thereby sacrificing whatever berries might have been harvested.

CRANBERRY BLOSSOM WORM.[1]

The cranberry blossom worm is a recently discovered cranberry pest in New Jersey, injury from this particular species not having been reported from other cranberry sections. There is little doubt, however, that the blossom worm has been causing losses, at least on New Jersey cranberry bogs, for many years; and, though its injury may have been noted from time to time, no attempt appears to have been made until recently to study the insect or to control it. It is apparent, also, that the amount of loss occasioned by the feeding of this insect has not been given due consideration, and it is not realized how great this loss may be.

Character of Injury.

Feeding is at first confined to skeletonizing the leaves or eating pieces out of the leaves, beginning at the margin and working toward the midrib, or boring into the buds, thus spoiling them for fruit production. The insect might be termed a budworm, since it destroys many of the buds, but its feeding becomes more noticeable in the blossoming season, when it cuts off the blossoms near where the stem joins the flower, and the ground then may be found littered with severed flowers. This habit of the worm is very wasteful of food, because many more blossoms are cut off than are consumed after the worm again goes to the ground.

Sometimes small round holes are bored into the young berries, but the worm does not remain within the fruit, as does the fruitworm. During the remainder of the season the eating of tender foliage is continued until growth is completed in late summer.

Description and Seasonal History.

Worms first appear on the bogs in late May and early June, hatching from eggs deposited the previous fall on the litter beneath the vines. Winter flowage appears to have no detrimental effect on the eggs and does not prevent them from hatching. Feeding continues, as outlined above, throughout the summer, and probably most of it is done at night, since the worms usually are found concealed in the trash in the daytime. The full-grown worm is about an inch in length, chocolate brown, with the head shining light brown. A whitish stripe runs lengthwise along each side of the smooth and well-rounded body (fig. 21).

[1] *Eniglaea apiata* Grote.

FIG. 21. — Cranberry blossom worm: Two larvæ. Enlarged.

Transformation to the pupa stage takes place in early September in deep trash or in an earthen cell slightly below the surface of the ground. The chrysalis is plump, brown, and measures about five-eighths of an inch in length.

Emergence of the moths begins in late September, and many will be on the wing in early October. The moth (fig. 22) is reddish brown above and slightly lighter in shade below. The forewings are marked with a few fine lines and irregular figures in dark brown. The thorax is tufted heavily, the hairs rising on the dorsal part to form a short keel. These months are of considerable size, measuring 1½ inches between the tips of the wings, and can be caught readily and recognized if one is watching for insect pests in October.

Egg laying is at its height in mid-October, and the moths are prolific layers. The egg is whitish, nearly round, except for a slight flattening at one end. The sides are deeply corrugated vertically. A few that have been collected on the bog under natural conditions were found firmly fastened to fallen leaves (fig. 23).

TREATMENT.

SPRAYING.

In the control of blossom worms very satisfactory results were obtained from a heavy application of arsenite of lime on June 30. Since the use of this form of arsenical is attended with some risk to the health of the vines, it is preferable to use some other arsenical, such as arsenate of lead. Apply the latter poison at the rate of 3 pounds of the paste or 1½ pounds of the powder to 50 gallons of water. This material is frequently used on cranberry vines with the addition of 2 pounds of resin-fishoil soap.

FIG. 22.—Cranberry blossom worm: Moth, or parent. Considerably enlarged.

REFLOWING.

Where water is available for fall reflowing, a great deal of good may be ac-

complished by flooding the bog for one week immediately after picking the crop. If the water is applied in October, when the moths have emerged from the ground and are resting among the vines, the flood will catch them as it rises and their death will follow in a day or two. Once the moth gets into the water it seems unable to free itself and soon perishes. It is probable that fall flooding also destroys the pupæ.

The spring reflow, if it can be applied in June for 48 hours, will serve to control blossom worms.

CRANBERRY KATYDID.[1]

Much of the damage to the fruit of the cranberry attributed to the feeding of grasshoppers must be charged to the cranberry katydid. New Jersey bogs still seem to be the favorite haunt of this insect and it ruins a large amount of fruit annually in its efforts to obtain the seeds of the growing berries. Naturally much of the pulp is removed in this operation, but for the most part it is rejected and falls to the ground. What is left of the berry, a mere shell, remains clinging to the vine in a shriveled condition, giving evidence of the nature of the culprit.

FIG. 23.—Cranberry blossom worm: Egg on cranberry leaf. Much enlarged.

The mature katydid is green, with exceedingly long hind legs and antennæ. At rest the semitransparent wings are folded close to the body and in this position the insect will measure about $1\frac{3}{4}$ inches from the head to the tips of the wings. The sound-producing instrument is borne only by the male and is at the base of the forewings, where they overlap. The female may be recognized easily by the sickle-shaped apparatus, at the end of the abdomen, by means of which the eggs are laid.

Young katydids first appear on the bogs about the middle of June but do not attain their full size until August. The berry-feeding habit is developed to full extent about the middle of July, when the insect has reached the stage immediately preceding the adult. Egg laying occurs in September and October, after which the adults die. Infestation of the succeeding year develops from the wintering eggs. These are laid in the blades of grasses, chiefly those known locally as "double seeded millet"[2] and "deer grass."[3]

[1] *Scudderia texensis* S. & P. [2] *Panicum viscidum.* [3] *Panicum dichotomum.*

The outline of the egg in a blade of millet may be seen by holding the blade to the light and the egg also can be detected by the slight swelling around the place of insertion. The egg is much flattened, kidney shaped, yellowish brown, and about three-sixteenths of an inch long. The shell is marked with figures ranging from regular hexagons on the flat sides of the egg to ovals and circles on the rounded edges. When placing the egg the female glues it to the inner walls of the grass blade and no portion of it may be seen from the outside.

TREATMENT.

Formerly it was inferred that the eggs would not survive winter flowage, but it has been demonstrated recently that the contrary is the case. Eggs found on a bog in double-seeded millet hatched the following June, after a winter of submergence lasting from December 1 to May 10.

Since the katydids do not lay eggs in cranberry leaves but select chiefly the blades of double-seeded millet and deer grass for the purpose, neither of these grasses should be allowed to grow either on the bogs or along the dams. For clearing dams of grasses a form of torch delivering a spray of burning kerosene will be found effective.

GRASSHOPPERS AND CRICKETS.

Much interest is manifested in grasshoppers and crickets by cranberry growers and many assertions are heard each year as to the quantity of berries that these insects destroy on various bogs. The most recent investigations dealing with these pests have shown that several of the common short-horned grasshoppers can and do eat cranberries on the vines in considerable quantities. Not only do they finish up berries that have been opened by katydids, but they open up sound berries and eat freely of the pulp. Grasshopper feeding gives to the berry the appearance of having been roughly gouged, while katydid feeding is deeper and leaves the berry more cleanly hollowed out.

Feeding tests of the short-horned grasshoppers indicate that two species in particular[1] go readily upon the vines and eat berries. These two species are very common throughout the cranberry district of New Jersey and often have been noted in large numbers on certain grassy and weedy bogs.

Meadow or long-horned grasshoppers undoubtedly destroy many berries on ill-kept bogs, but there is no evidence to show that crickets will attack berries on the vines, although they have been known to feed on berries on the ground. Crickets lay their eggs along the

[1] *Schistocerca alutacea* Harr. and *Melanoplus bivittatus* Say.

sandy dams and sandy spots in the bogs, but the meadow grasshoppers lay theirs in the stems of sedges, rushes, and large grasses.

A number of growers contend that although the great injury to the cranberry crop wrought by the katydid is rightly recognized, too little importance has been laid upon the injuriousness of both the short and the long horned grasshoppers. The contention appears to be well founded.

Treatment.

The most effective way to keep a bog free of grasshoppers is to keep it free of grasses and plants other than cranberry. Weedy bogs are the only ones that suffer appreciable losses from grasshopper feeding, and a bog inhabited annually by large numbers of grasshoppers can not become a source of profit until it is free of them.

Aside from those bogs which are so overspread with undesirable growth that they require a complete drowning out lasting at least two years, there are others in which it would be profitable to hold the winter flowage until mid-July of one season in order to get rid of some of the objectionable weeds. This latter treatment also would be effective in clearing the bog of the grasshoppers and crickets for a season or two, and this condition could be made permanent by carrying out methods of better culture. Many of the grassy bogs need better drainage, more ditches, some pruning, and some sanding.

POISONED-BRAN BAIT.

Very effective results in the killing of grasshopers have been obtained in various parts of the United States by broadcasting poisoned-bran bait. One instance is known in New Jersey where this material proved of great value in destroying grasshoppers on a cranberry bog, and, although its use on bogs has been very limited, it is deserving of further trials. The formula for its preparation is as follows: Wheat bran, 25 pounds; Paris green, 1 pound, or white arsenic, 1 pound; lemons or oranges, 6 fruits; low-grade molasses, 2 quarts; water, 3 gallons.

Mix the bran and poison while dry; add the molasses, the juice of the fruit, and the finely chopped pulp and rind of the fruit to the water. Pour the resulting liquid over the poisoned bran and stir well to dampen it thoroughly. This amount of material should be broadcasted over 5 acres of bog, making the application late in the evening, or, preferably, very early in the morning, as at this time the grasshoppers are just beginning to feed. The bait is not attractive to the insects when dry, and two applications should be made, two days apart. In mixing the bran and poison use a spade or other implement, so as to avoid absorption of the poison by the hands and forearms. The damp mash may be sown with the bare hands.

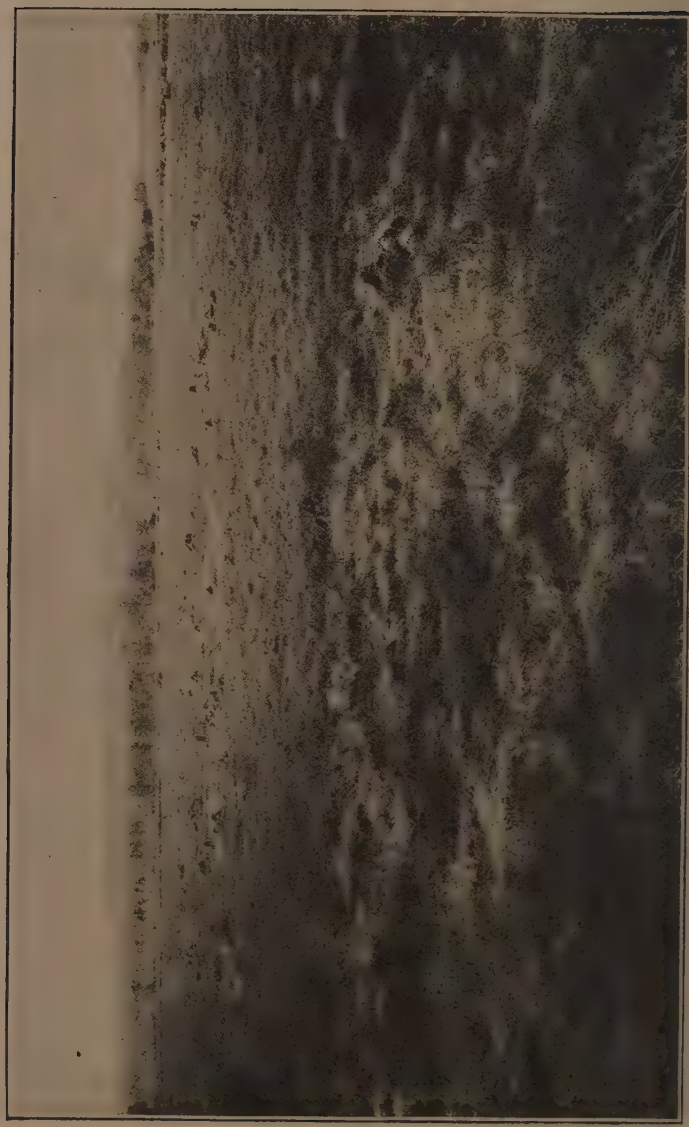

FIG. 24.—Work of the cranberry girdler in cranberry bog. The vines in the foreground have been largely killed by this insect.

VINE-ATTACKING INSECTS.

CRANBERRY GIRDLER.[1]

The cranberry girdler is the most destructive of insects that attack the vines and is the cause of large losses each year, particularly in New Jersey. Although the pest is rather common in Wisconsin, the damage on cranberry bogs in that State has not been severe, probably because the marshes are, as a rule, wetter than those in the Eastern States. The girdler is distributed widely throughout the United States and other countries and is known to many as a pest of grasses.

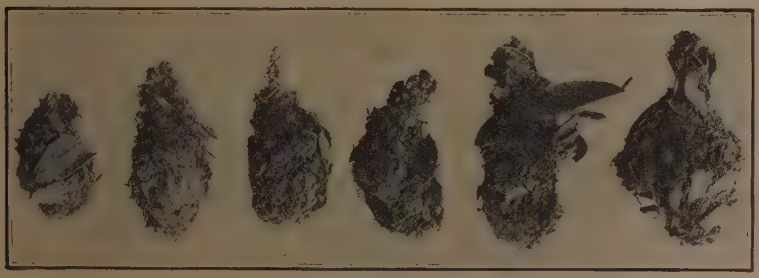

FIG. 25.—Cranberry girdler: Cocoons. Enlarged.

Its known food plants are few, however, and it seems to have become more destructive to cranberry than to any other crop. The work of this insect on the bogs is very noticeable, but owing to the concealed feeding habit of the worms few growers ever find them and not infrequently the damage is attributed to other causes and steps to control the worms are not taken.

CHARACTER OF INJURY.

Injury to the vines is caused by the feeding of the worms on the stems and runners and, to some extent, on the roots. Not only is the bark eaten but the wood itself is gnawed, frequently resulting in the complete severing of a runner. The plant at its crown is very liable to be girdled, resulting in quick death of the leaves and branches beyond. The feeding marks are usually associated with quantities of castings, or excrement, more or less held together by strands of silk.

The character of the injury is such that large areas of the vines may be killed in the course of a single season, and if the worms are left unchecked these areas will grow larger from year to year. (Fig. 24.) Entire bogs are rarely, if ever, attacked. There appear to be certain parts of every bog, particularly the higher and well-drained parts, where the vines are underlain with large quantities of trash, which are more favorable for girdler development and it is

[1] *Crambus hortuellus* Hübner.

these areas which suffer most. Where the injury is less severe the killed spots may range from 2 or 3 feet in diameter to areas of a square rod or more. After the second year the tendency is for the smaller spots to become revined, but this is in all cases a slow process. Even a severe infestation seldom is detected until late summer, when the foliage of the injured vines assumes a reddish cast, but in the fall the injured areas are very noticeable with their red and brown leaves and lifeless vines. The following spring most of the leaves will have shattered, leaving areas of naked, dead vines.

Description and Seasonal History.

Hibernation and period of cocooning.

After completing its feeding in the early fall the worm forms a cocoon (fig. 25), composed of bits of trash from the bog floor, sometimes largely of pieces of twigs and leaves and sometimes of sand, lined with silk. The cocoon is formed in the trash itself, and, being of the same character as the trash, is very difficult to find. It is not impervious to water and, in fact, becomes full of water within three or four days after the turning on of the winter flowage, but the worm is not injured by such treatment.

The importance of obtaining the correct date for the period of cocooning can not be overestimated, because upon it depends the success or failure of the fall flooding. In New Jersey the period when the worms make their cocoons begins about the last week in September and is at its height during the first week in October.

The moth.

Upon the removal of the winter flowage in the spring the change from the larva to the pupa occurs within 2 or 3 weeks, and this in turn is followed shortly by the emergence of the moth from the cocoon. For example, if the winter flowage is removed May 10,

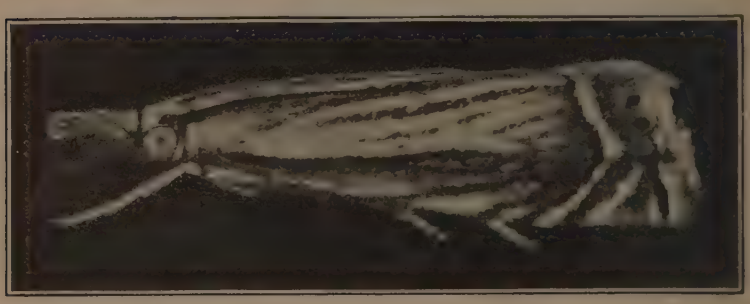

Fig. 26.—Cranberry girdler: Moth, or parent insect. Much enlarged.

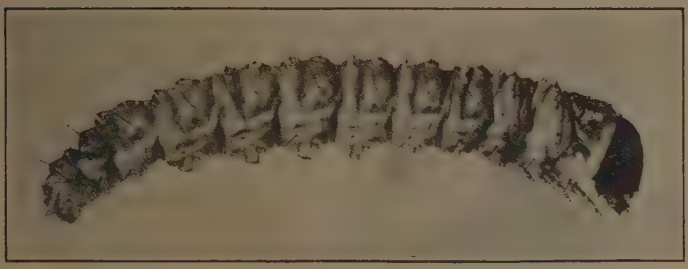

FIG. 27.—Cranberry girdler: Larva. Much enlarged.

pupæ will be found in the cocoons early in June and moths will be emerging in large numbers about June 15. The adult (fig. 26) measures about three-fifths of an inch in maximum wing expanse. Flying about the bog it has a whitish appearance, but in reality the ground color of the forewings is pale straw, bearing touches of brown, silver, and black, with a fringe of silver. The hind wings are silvery gray.

ONE GENERATION ONLY.

Moths may be seen flying on the bogs from May until August, and it has been thought by many persons that at least two generations occur in a season. This, however, is not the case, there being only one brood of worms a year. On dry bogs the moths may be expected to emerge in May and June, and in some spots on flowed bogs where the vine growth is especially heavy, and where, perhaps, the water has been slow in draining, emergence of moths will not take place until July. These late-emerging moths may fly for several weeks and thus give the appearance of a second brood. The moths are prolific layers, dropping their eggs on the trash beneath the vines.

THE EGG.

The eggs are white at first, becoming pink and then red as hatching approaches; they are oval in outline and slightly flattened at the poles, with ribs running vertically from pole to pole. Owing to their minute size, it is practically impossible to find them on the trash.

THE LARVA.

The newly hatched larva is an active, hairy specimen and almost never is encountered owing to its minuteness, dirty color, and the fact that it works in the fallen leaves beneath the vines, where the finding of a full-grown worm is indeed difficult. Early feeding seems to be of little importance, but in August and September the worms are ravenuous feeders, consuming large amounts of bark and wood.

FIG. 28.—Cranberry toadbug: Short-winged form of adult. Much enlarged.

They work almost entirely in the layer of trash which covers the runners and will not be found beneath the surface of the soil itself. The mature worm (fig. 27) measures about five-eighths of an inch and has a body of a pale, smoky color, with a brown head.

TREATMENT.

FALL FLOODING.

The treatment which gives the most complete control, amounting practically to extermination of the worms, is the fall flooding of the bog for a period of one week, beginning the latter part of September and certainly not later than the first week in October. The object is to get the water on the bog while the worms are naked and before they have formed cocoons. If flooding is practiced after the worms have cocooned, the water may be kept on the bog all winter without injuring them. The difficulty in carrying out this method of control is either a lack of storage water or the lateness in ripening of the fruit.

LATE HOLDING OF THE WINTER FLOWAGE.

Maintaining the winter flowage until July 20, with the consequent loss of the current season's crop, is the method frequently used to check severe infestations. If disastrous frosts are not met the following year, the crop of that year may be expected to be about double that of a normal season. Holding the winter flowage until July 1 permits some of the moths to emerge from their cocoons, but holding until August 1 is likely to prevent a good set of buds for the following year.

SPRING REFLOWING.

No dependence can be placed on spring reflows as a control measure against the cranberry girdler, even on those lasting as long as 5 days during the period of pupation.

SANDING.

Many bogs can not be fall flooded, and on some the winter flowage can not be held until July 20. For these there seems to be no recourse

but sanding, which preferably is done in late fall, but may be done on the ice or in early spring. On many of the unsanded bogs where the trash is heavy little benefit will result unless a 2-inch coat of sand is applied. The sand benefits the bog by covering the injured runners, giving them an opportunity to throw out new roots, and by making conditions unsuitable for the development of another generation of the girdlers. If the coat of sand is sufficiently thick it will prevent the emergence of the girdler moths from their cocoons. No method of control by spraying or by the use of repellents has been developed.

CRANBERRY TOADBUG.[1]

One of the newer pests to be brought to the attention of cranberry growers is the cranberry toadbug, which first made itself of prime importance on some of the Long Island bogs and at about the same time appeared in New Jersey. The Massachusetts and Wisconsin bogs appear not to have been troubled, at least not to a serious extent, by this insect. The bugs rarely are found on any other plants in the neighborhood of the bogs and cranberry seems to be the only host which is injured in a large way.

Character of Injury.

The insect gets its food by sucking the juices of the plant through a long beak, and on cranberry the beak is inserted in the woody stems and apparently never in the foliage. Feeding on the old wood causes a dwarfing of the fruit on the branches beyond, and when a bug takes sap from the new wood the fruit will shrivel and death of the branch will result. The first signs of injury usually are noted in July, when the foliage assumes a reddish tinge, later becoming brown, and, as the injury progresses, many dead uprights bearing brown leaves will be found throughout the area.

Fig. 29. — Cranberry toadbug: Long-winged form of adult. Much enlarged.

Description and Seasonal History.

The adult bug, which is about three-sixteenths of an inch in length, is found in several forms, some of which are black, with short wings (fig. 28); some brown, with short wings; and some usually black but occasionally brown, with long wings

[1] *Phylloscelis atra* Germar.

FIG. 30.—Cranberry toadbug: Immature toadbug, or nymph. Much enlarged.

(fig. 29). The long-winged forms migrate in the fall, but by far the majority of the bugs have short elytra and abortive wings and remain on the bog. The bugs, both adult and nymph (fig. 30), are strong jumpers and move so quickly that seldom can they be located a second time. Eggs are laid during September and October, and in the operation of depositing them one is held at the tip of the abdomen by the female while she coats the entire egg with fine particles of dirt and grains of sand, after which she moves away, allowing the egg to drag on the ground until it drops off. The eggs remain on the floor of the bog until the following summer, being able to withstand both fall and winter flowage. Hatching occurs in late June and July and for a few days in August. The nymphs secrete a cottony material which breaks away from their bodies and coats the uprights on which they are feeding. Such white-coated uprights are, as a rule, indicative of toadbugs, but a similar effect is sometimes produced by the cranberry vinehopper.[1] The nymphs molt five times and the cast skins, clinging to the uprights, may be mistaken for the bugs themselves. Adults first appear in August.

TREATMENT.

The few severe outbreaks which have been observed in New Jersey have died out of their own accord. Among the natural controls of the pest are an insect parasite that produces a black hump on the back of the nymph and a fungous disease that has the appearance of the white mold.

FLOODING.

If water is available for summer use, the bog should be flooded, preferably in cloudy weather, some time between August 1 and 15. Instances are on record where such flooding was practiced for 48 hours without injury to the berry crop. Weeds and grasses which project above the flowage should not be allowed to remain. A good wind will blow the bugs to the shore, where they may be killed with a spray of burning kerosene.

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[1] *Amphiscepa bivittata* Say.

SPRAYING.

Where water is not available for flooding the bugs off, a method of spraying worked out on Long Island as reported in Bulletin No. 377 of the New York Agricultural Experiment Station, may be tried. Heavy growth of vines must be mowed at the usual season for cutting and the spray applied between August 1 and 15, using soap solution, 1 pound to 7 gallons, and applying it at the rate of 200 gallons per acre. Two applications should be given.

OTHER CRANBERRY STEM FEEDERS.

CRANBERRY VINEHOPPER.[1]

Perhaps the most frequently encountered of the lesser pests of the woody parts of the cranberry is the cranberry vinehopper, which almost invariably is found where the vines have been weakened by some other agency. Adult bugs (fig. 31) are usually green, rarely pink, with large wings, giving them a flat-sided appearance, and are about one-fourth of an inch in length. They appear in July and August, and in late summer deposit their eggs in slits made with a sawlike ovipositor in live, woody stems (fig. 32) and, as frequently, in dry, dead pieces of cranberry wood on the ground. The eggs survive winter flowage and hatch in late June, when a succession of whitish nymphs, or young, bearing cottony secretions of wax appear. The nymphs are active jumpers, and the adults have the power of flying as well as jumping. Food is obtained by sucking the juices from uprights and runners.

The bugs could be removed by flooding in late July, but as a general rule they will need no treatment and will not infest a bog in large numbers if the vines are kept in a healthy, productive condition.

FIG. 31.—Cranberry vinehopper: Adults on cranberry stem. Considerably enlarged.

[1] *Amphiscepa bivittata* Say.

Cranberry Spittle Insect.[1]

Records of the last few years in New Jersey show that the cranberry spittle insect is of more consequence on blueberry than on cranberry. From time to time, however, it has been brought to the attention of growers in Massachusetts and Wisconsin as a sucking insect of the vine. The masses of spittle which cover the nymph serve as a means of identifying this feeder, and it has been rarely if ever of sufficient importance to warrant the application of remedial measures.

Fig. 32.—Cranberry vinehopper: Injury to cranberry stem by oviposition of adults, and the eggs in position in the stem. Much enlarged.

A Mealybug.[2]

Where the vines have been injured recently by the cranberry girdler there will be found frequently masses of white, cottony material (fig. 33) along the injured portions of the runners. On closer inspection this cottony material will be seen to cover the backs of the mealybugs, and in some cases their eggs or young. The bugs live by sucking sap from the vines, and it appears that conditions are more suitable for obtaining food where the vines have been gnawed by the girdlers. Vines in healthy condition appear not to be infested to any great extent by mealybugs.

Scale Insects.

In recent years some of the scale insects have proved decidedly injurious to cranberry vines, notably the Putnam scale,[3] on Long Island, and the oyster-shell scale,[4] in Massachusetts, although in the latter case the scale apparently is able to maintain itself only on dry bogs.

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[1] *Clastoptera proteus* Fitch.
[2] *Pseudococcus adonidum* L.
[3] *Aspidiotus ancylus* Putnam.
[4] *Lepidosaphes ulmi* L.

The Putnam scale is a formidable enemy, attacking not only the woody parts but also the leaves and fruit. Badly encrusted vines become very red of foliage and may be detected from a considerable distance. Infestation is likely to occur in areas, dotted here and there over the bog, from 2 or 3 feet in diameter to those comprising several square rods. Infested fruit becomes unsuitable for marketing and infested vines bear dwarfed fruit or are killed outright.

The use of water as a control for the Putnam scale seems to be barren of results, for the scales in the immature form hibernate beneath the winter flowage, and bogs that frequently are reflowed continue to be infested by them. They are difficult to reach by spraying, not only because the foliage prevents the spray from wetting them thoroughly, but also because many of the scales settle on the runners buried in the trash. Mowing the infested vines in the early spring, removing and burning the cut vines, and spraying the area with pure kerosene may prove to be an effective treatment Kerosene also may be used on the vines about the middle of August with fair impunity to the foliage but with damage to the fruit. This spray should be applied as a fine mist and used with care. Both lime-sulphur and a commercial preparation of soluble oil have proved harmful to dormant vines when used at the proper dilution for scale-killing. A fungous parasite[1] seems to be doing good work on certain bogs in destroying scales.

FIG. 33.—Mealybug, *Pseudococcus adonidum:* Colony of mealybugs on cranberry runner. Much enlarged.

ROOT-ATTACKING INSECTS.

CRANBERRY ROOTWORM.[2]

Insects whose feeding on the roots of cranberry is of much consequence appear to be few, but of these the cranberry rootworm is probably the most injurious. Undoubtedly this has been long a pest of cranberry, but its discovery in that connection was not made until recently in New Jersey. The beetle has been found lately on a Long Island bog and the pest has been discovered on cranberry in Massachusetts.

[1] *Sphaerostilbe coccophila* (Des.) Tul.

[2] *Rhabdopterus picipes* Oliv.

Although widely distributed throughout the United States, it appears not to have attained any importance economically until its root-feeding habit on cranberry was made known. Myrtle, wild grape, and basswood were its most frequently mentioned hosts, but to these should now be added the roots, foliage, and fruit of cranberry, and the roots and foliage of swamp blueberry.

Character of Injury.

The feeding of the beetles on the foliage and fruit of the cranberry is of minor consequence, although it does afford an opportunity

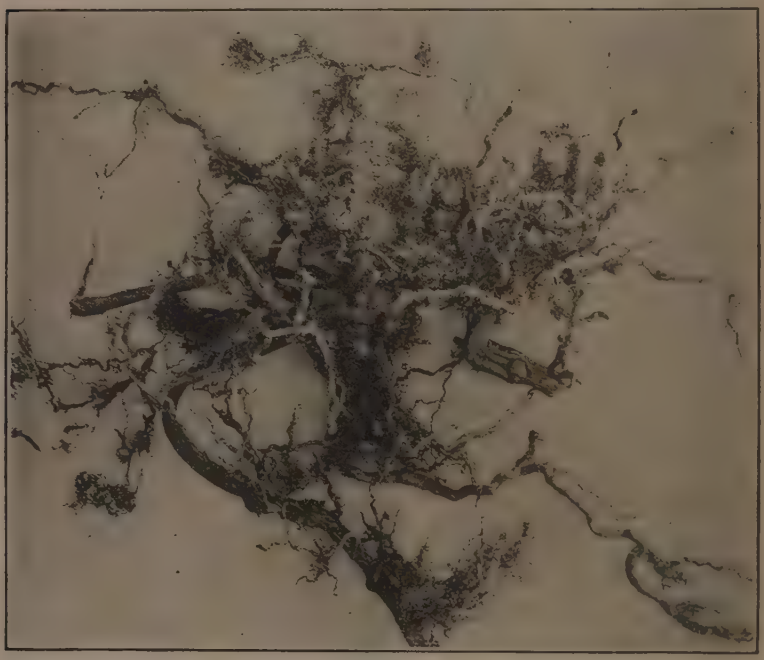

Fig. 34.—Cranberry rootworm: Injury to roots by the larvæ, or grubs.

of control by spraying with an arsenical. On the other hand, the worms, or grubs, which live in the soil beneath the vines, devour the fine roots and eat the bark of the large roots and runners, particularly where the latter come in contact with the ground. (Fig. 34.) This insect's feeding habits differ from those of the girdler in that it does its work beneath the surface of the ground, whereas the girdler feeds above the surface, concealed in the layer of trash which covers the runners.

Vines growing on sandy land suffer most, although severe infestations have been found on muck bottoms.

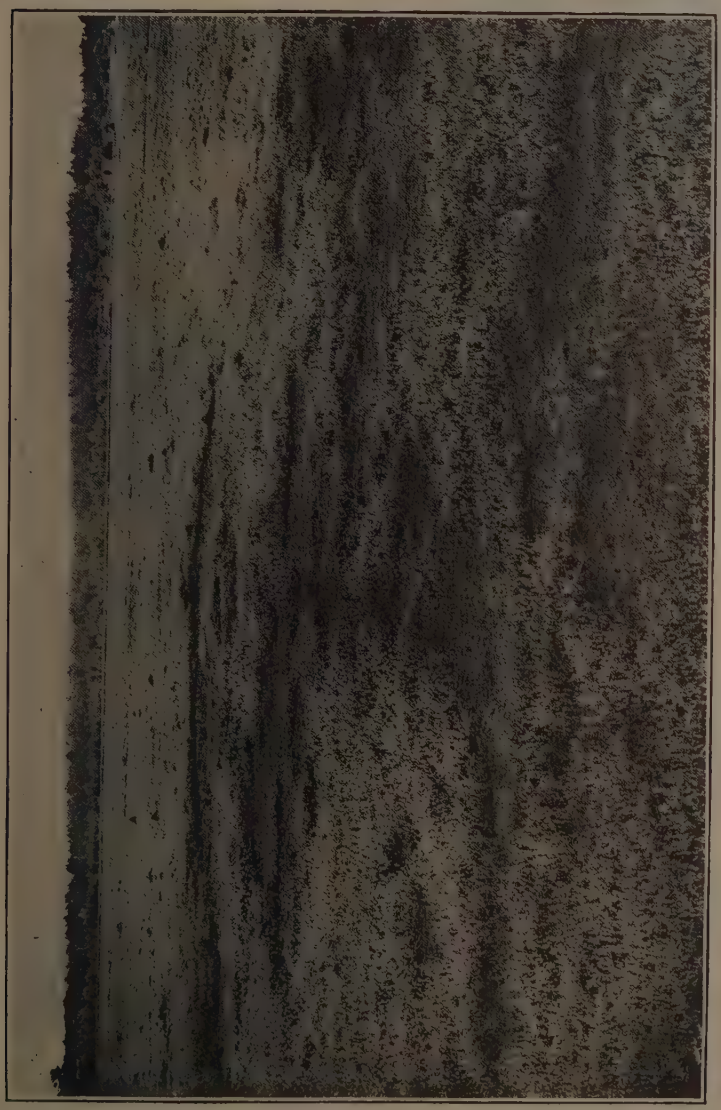

FIG. 35.—Cranberry rootworm: Cranberry marsh, showing, in the foreground, patches of vines killed by the larvæ.

Rootworm injury is first indicated by the reddish color of the foliage in late summer, followed by death of the vines and shattering

FIG. 36.—Cranberry rootworm: Larva, or grub. Much enlarged.

of the leaves. Such conditions are seldom of large area, usually being confined to spots ranging in area from one to several square rods along the high margins or on relatively high and sandy areas in the interior of the bogs. (Fig. 35.)

DESCRIPTION AND SEASONAL HISTORY.

HIBERNATION.

Hibernation occurs in the grub stage, from 1 to 10 inches deep in the bog soil, and is accomplished safely even on winter-flowed bogs. The grubs lie in their earthen cells until after the flowage is drawn off in the spring, when the more deeply buried ones move closer to the surface and all transform to pupæ, soon after which the emergence of the beetles takes place. The holes which the beetles leave in the soil may be seen easily on hard, sandy bottoms where there is little trash.

THE LARVA.

Most of the life of the rootworm, or about 10½ months on an average, is spent in the larval stage. Grubs may be found, however, at any season, because each year a few fail to complete their growth and therefore spend two winters in the ground.

The full-grown larva (fig. 36) is about five-sixteenths of an inch long, whitish, with brown head, and usually lies in a curved position.

Hatching of the yellow eggs begins in mid-July and the grubs then commence their root feeding, which lasts until early October, when hibernation begins.

THE PUPA.

Transformation from grub to pupa takes place in late May and early June, the time depending upon the date of removing the winter flowage; late holding of the flowage acts as a delay of pupation. Pupæ usually are found in the surface inch of soil and the stage lasts about 2 weeks. The pupa (fig. 37) is white and slightly shorter than a full-grown larva.

THE BEETLE.

Emergence of the beetles from the soil begins about mid-June and is at its height a few days later. In a cage placed over a badly injured area of vines an average of 20 beetles emerged to the square foot. During the day they are not found so readily as at night, when

with a sweep-net 40 to 50 may be caught in four or five sweeps.

The beetle (fig. 38) measures slightly less than one-fourth inch and is shining mahogany brown. The usual duration of life is 1 month to 6 weeks, and during this time the eggs are laid singly, or in masses of as many as 50, just beneath the surface of the soil or on litter under the vines.

FIG. 37. — Cranberry rootworm: Pupa. Much enlarged.

TREATMENT.

Flooding the bog to control this insect is of little avail unless it be done when the beetles are feeding on the foliage in the latter part of June and early July. Since this time is also the beginning of the blooming period, a good deal of injury would result to the crop by reflowing, and such treatment can not be recommended unless it is desired to rest the bog by destroying the bloom. During the larval and pupal stages the rootworm can survive prolonged reflowing, and no dependence can be placed upon spring or fall reflows to exterminate it or even lessen its numbers appreciably.

Invigorating the vine growth by sanding on muck bottom and applying commercial fertilizer on sandy bottom promises good results in sustaining the vine growth, but should be accompanied by spraying, for which purpose one of the arsenicals may be used. Arsenate of lead is a satisfactory insecticide and should be applied at the rate of 3 pounds of the paste, or half that amount of the powder, to 50 gallons of water. Burning of the foliage has not been noted where 2 pounds of fish-oil soap have been included. The arsenical also may be used in combination with the Bordeaux and soap spray. At least two applications should be made, one about June 25 and the other as soon as the bloom has fallen.

FIG. 38.—Cranberry rootworm: Adult, or beetle. Much enlarged.

Carbon disulphid injected into the soil was found unsatisfactory and very expensive in an effort made to kill the larvæ.

WHITE GRUBS.[1]

The large root-feeding white grubs are found occasionally in cranberry bogs, but rarely are of much importance. The specific injury results from the feeding of the grubs on the fine roots of the vines, these being cut off completely, so that the vines with a thin layer of turf may be easily lifted and rolled back like a rug. The grubs then will be found at the surface or very near the surface of the exposed ground.

Fall reflowing for a period of 10 days, from October 25 to November 4, did not kill grubs in the soil, and they hibernate with safety on winter-flowed bogs. For small infestations of a few square rods it seems best to "turf off" the infested area, which will be defined closely by the dead vines, and to reset with new vines.

Should a large area be infested and the destruction of the bog be threatened, it is probable that holding the winter flowage until July 15 would rid the bog of grubs.

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[1]Particularly *Phytalus georgianus* Horn., *Dyscinetus trachypygus* Burm. and *Lachnosterna grandis* Sm.

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